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AUTHOR Stein, Barry S.; And Others
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ABSTRACT

Research indicates that people do not spontaneously transfer prior clues to solve problems, even though the necessary information is available in memory. To investigate the effects of the symmetry between clue statements and problem statements on problem solving performance, subjects were asked to provide plausible explanations for five incomprehensible sentences. The clue words for clarifying the sentences were embedded in four types of sentence contexts: (1) similar surface/similar deep (containing at least two words also found in the problem statement/or an underlying relational structure similar to the problem statement); (2) dissimilar surface/similar deep; (3) similar surface/dissimilar deep; (4) dissimilar surface/dissimilar deep; and irrelevant clues. In the experiment subjects were given a list of 15 statements and asked either to rate their truthfulness or memorize them. After 30 seconds the five problem statements were presented. Subjects either were informed or uninformed about the relevance of the clues. Clues embedded in sentences that had little deep structural similarity to the problem statement did not facilitate problem solving unless subjects were informed about the potential relevance of those clues, regardless of whether they rated or memorized the clue sentences. However, clues in statements that had high deep structural similarity to the problem statement did facilitate problem solving in both the informed and uninformed conditions. These results suggest that the similarity in deep structure between the clue encoding context and the problem encoding context is an important determinant of transfer. (JAC)

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Constraints on the Automaticity of Transfer in Problem Solving

Barry S. Stein

Sammie Benningfield

Cathleen A. Hedgecough

Tennessee Technological University

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One research paradigm that has been used to investigate transfer focusses on variables affecting problem solving performance. In this research people are initially exposed to clues that should help them solve problems presented at a later time in the experiment. If transfer occurs the performance of people who were given relevant clue information ahead of time will be superior to the performance of a control group that receives no clues. Previous investigations in this area indicate that people do not spontaneously transfer these clues to the problems even though the necessary information is available in memory. It appears that subjects do not automatically access information for solving a problem unless they are told that the information studied ahead of time is relevant (e.g., Judson, Cofer & Gelfand, 1956; Weisberg, Dicamillo & Phillips, 1978; Perfetto, Bransford and Franks, 1983). In these studies, subjects only transfered relevant information when explicitly prompted to do so. Outside of laboratory settings, people must decide for themselves what information is relevant and should be retrieved. Therefore it is important to understand factors that influence and constrain the automatic access of information that is relevant to an individual's goals.

One factor that has been shown to influence the accessibility of information is the degree of symmetry between the acquisition and the retrieval context (e.g., Tulving & Thomson, 1973). The present study investigates the effects of the symmetry between clue statements and problem statements on problem solving performance. Specifically, we manipulated the surface structure similarity and deep structure similarity of the clues to the problem statements.

Method

In the present study, subjects were asked to provide plausable explanations for 5 incomprehensible sentences. The sentences which comprised the problem set were adapted from Auble, Franks, & Soraci (1979). The clue words used by Auble et al. for clarifying these incomprehensible statements were embedded in four types of sentence contexts (similar surface/similar deep, dissimilar surface/similar deep, similar surface/dissimilar deep, dissimilar surface/dissimilar deep, and irrelevant clues). These conditions are shown in Table 1.

Similar surface structure clue contexts contained at least 2 words that were found in the problem statement. Similar deep structure clues had an underlying relational structure that was similar to the problem statement. For example, given the problem statement "the home was small because the sun came out", a SS/SD clue is "an igloo is a home that can be damaged by heat"; a DS/SD clue is "an igloo can be damaged by heat"; a SS/DD clue is "after being out in the sun, my home feels like an igloo"; a DS/DD clue is "some Eskimos live in an igloo"; the irrelevant clue is "airplanes are safer than automobiles". Subjects in each condition were given 5 clue sentences from one of the five conditions shown in table 1. During acquistion these five clue sentences were embedded in a list with 10 other sentences that were unrelated to the clues or problems.

In the experiment subjects were given a list of 15 statements, and were instructed either to rate the sentences or to memorize them. In the rating situation, subjects rated the truthfulness of the 15 statements using a 3 point scale: 1-always true, 2-sometimes true

or 3-never true. Subjects in the memorization condition were given 2 minutes to study the sentences followed by a 3 minute recall test. This study-recall procedure was repeated until a criterion of no errors was reached--usually 3 to 4 trails.

After rating or memorizing the 15 sentences, a period of 30 seconds elasped before the subjects were presented with the 5 problem statements.

In addition to manipulating the clue context and the form of acquisition, the experiment manipulated whether or not subjects were informed about the relevance of the clues for solving the problems. Subjects in the informed groups were told that clues for the problem statements may have been present in the acquisition list which they had either rated or memorized. Subjects in the uninformed groups were not told about the potential relevance of the clues in the acquisition list before solving the problems.

Results

A 2 x 2 x 5 between groups analysis of variance was performed on the number of problems solved correctly. Significant treatment effects were found for the Clue Context, $F(4,180) = 82.23$, $p < .001$, Relevance instructions, $F(1,180) = 113.96$, $p < .001$, and the interaction between Clue Context and Relevance Instructions, $F(4,180) = 10.17$, $p < .001$, $MS_e = .776$. No other treatment effects or interactions were significant. Table 2 provides a summary of the mean percentage of problems solved correctly averaged across the Memorizing and Rating conditions.

Several comparisons were performed using Dunn's Multiple Comparison Procedure (t') to investigate the interactions. To assess the degree of transfer of clues to the problem solving tasks, performance in each condition was compared to the performance of the control group who received irrelevant clues that would not help them solve the problems.

When uninformed subjects were given dissimilar deep - dissimilar surface structure clues, no automatic transfer was found, $t'(180) = .18$, $p > .05$. However, when informed subjects were given dissimilar deep - dissimilar surface structure clues, performance was significantly greater than the Control group, $t'(180) = 4.29$, $p < .01$. This indicates that the dissimilar deep - dissimilar surface structure clue statements could facilitate problem solving.

When uninformed subjects were given dissimilar deep - similar surface structure clues, no automatic transfer was found, $t'(180) = 1.96$, $p > .05$. However, when informed subjects were given dissimilar deep - similar surface structure clues, performance was significantly greater than the control group $t'(180) = 5.18$, $p < .01$. This also indicates that the dissimilar deep - similar surface structure clue statements could facilitate problem solving.

Subjects given similar deep - dissimilar surface structure clues who were uninformed about the relevance of the clue for solving the problems showed automatic transfer, $t'(180) = 4.11$, $p < .01$. Likewise, the informed group given similar deep - dissimilar surface structure clues performed significantly better than the control group $t'(180) = 12.5$,

$p < .01$. Significantly more transfer was found in the informed group than in the uninformed group $t'(180) = 8.75$, $p < .01$.

Similar results were found when subjects received similar deep - similar surface structure clues. When subjects were given similar deep - similar surface structure clues without being informed, performance was significantly better than the control group, $t'(180) = 7.86$, $p < .01$, indicating automatic transfer did occur. Significantly more transfer occured in the informed condition than in the uninformed condition, $t'(180) = 6.57$, $p < .01$.

When not informed as to the relevance of the clue statements, significantly more automatic transfer of clue information occured when subjects received similar surface structure - similar deep structure clues than when they received dissimilar surface structure - similar deep structure clues, $t'(180) = 3.76$, $p < .01$.

Discussion

The results of the present study replicate and extend previous research investigating the transfer of information in problem solving tasks. Our findings indicate that the similarity of the clue sentence to the problem statement can affect the degree to which people automatically transfer clues to the problem task. Specifically, when subjects were given clues embedded in sentences that had little deep structure similarity to the problem statement it did not facilitate problem solving unless they were informed about the potential relevance of those clues. This pattern of results was obtained regardless of

whether subjects rated clue sentences or memorized clue sentences. These findings are consistent with earlier work by Weisberg et al. (1978) and Perfetto et al. (1983), indicating transfer of information is not always an automatic process.

However the present study also shows that when subjects are given clues embedded in statements that had high deep structure similarity to the problem statement it did facilitate problem solving in both the informed and uninformed conditions. These results suggest that the similarity in deep structure between the clue encoding context and the problem encoding context is an important determinant of transfer. While the degree of surface structure similarity between clue statements and problem statements tended to increase transfer it was not a necessary or sufficient factor in itself.

In conclusion the findings indicate that the degree of deep structure similarity between clue encoding context and the problem encoding context is an important determinant of transfer.

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Constraints on Transfer

Table 1

Examples of Problems and Clues

Problem Statement: "The home was small because the sun came out."

Clue Statements:

1. Similar Surface/Similar Deep (SS/SD)

   "An igloo is a home that can be damaged by the sun."

2. Dissimilar Surface/Similar Deep (DS/SD)

   "An igloo can be damaged by heat."

3. Similar Surface/Dissimilar Deep (SS/DD)

   "After being out in the sun, my home feels like an igloo."

4. Dissimilar Surface/Dissimilar Deep (DS/DD)

   "Some Eskimos live in an igloo."

5. Control (Irrelevant)

   Airplanes are safer than automobiles.

Table 2

Mean Percent of Problems Solved

	Clue Context				
	SS/SD	DS/SD	SS/DD	DS/DD	Control (Irrelevant)
Informed	82	73	32	27	3
Uninformed	45	24	12	2	1